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METEOROLOGICAL DATA FOR THE TITAN 3C LAUNCH  
IN DECEMBER 1973 (NASA) 40 p HC \$4.00

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## NASA TECHNICAL MEMORANDUM

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COMPENDIUM OF METEOROLOGICAL DATA FOR THE  
TITAN III C LAUNCH IN DECEMBER 1973

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*George C. Marshall Space Flight Center  
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16. ABSTRACT  All the meteorological data for the 19-hour period before the Titan III C (AF-777) launch from Kennedy Space Center at 1857 EST on December 13, 1973, are archived at the Marshall Space Flight Center. These data were collected in support of the NASA rocket exhaust effluent prediction and monitoring program. This data set is unique in that soundings were made with a high temporal resolution. All supporting data, such as synoptic charts and surface data, are also included. This is the first in a series of seven data reports.			
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## TECHNICAL MEMORANDUM X-73334

# COMPENDIUM OF METEOROLOGICAL DATA FOR THE TITAN III C LAUNCH IN DECEMBER 1973

## I. INTRODUCTION

This report is a compendium of all the meteorological data collected as a function of the Marshall Space Flight Center (MSFC)/Langley Research Center (LaRC)/Kennedy Space Center (KSC) rocket exhaust effluent prediction and monitoring program for the Titan III C launch (AF-777) from launch pad 40, Kennedy Space Center, at 1857 EST on December 13, 1973. The data presented in this compendium were collected largely to support NASA/MSFC diffusion predictions for the deployment of NASA/LaRC monitoring sites. The joint solid rocket motor exhaust prediction (MSFC) and measurement (LaRC and KSC) program evolved in 1972 utilizing the Titan and Delta launches as a source for empirical information that can be employed to more accurately predict the environmental effects of planned Space Shuttle operations.

These data are archived both as an aid in postlaunch analysis and because they represent a unique set of atmospheric soundings with high temporal resolution. Included in the report are the synoptic charts, surface observations, rawinsonde soundings, and satellite imagery. There is no attempt to analyze any of the data.

## II. DATA

The data are listed in Appendices A through D; page numbers for specific data are given in the Table of Contents. The dates, times, and sources of the data are listed in Table 1.

The synoptic charts are from the series published weekly by the National Oceanographic and Atmospheric Administration (NOAA). The surface data are from the Cape Canaveral Air Force Station (location shown as KSC meteorological station in Figure 1).

**TABLE 1. METEOROLOGICAL DATA SUMMARY FOR TITAN III C  
(AF-777) LAUNCH ON 13 DECEMBER 1973 AT 1857 EST (2357Z)**

Data Type	Date (Dec 1973)	Time		Source
		EST	Relative <sup>a</sup>	
Synoptic Charts <sup>b</sup>	12	0700	T-35 hr 57 min	NOAA
	13	0700	T-11 hr 57 min	NOAA
	14	0700	T+12 hr 3 min	NOAA
Surface Observations <sup>c</sup>	13, 14	0058 13 Dec to 2358 14 Dec	T-17 hr 59 min to T+29 hr 1 min	USAF
Rawinsonde	13	0015	T-18 hr 42 min	USAF
	13	0457	T-14 hr	USAF
	13	0757	T-11 hr	USAF
	13	1057	T- 8 hr	USAF
	13	1357	T- 5 hr	USAF
	13	1557	T- 3 hr	USAF
	13	1901	T+ 4 min	USAF
	14	0015	T+ 5 hr 18 min	USAF
	14	0615	T 11 hr 18 min	USAF
	14	1215	T+17 hr 18 min	USAF
Satellite Imagery (IR)	12	2120	T-21 hr 37 min	NOAA

<sup>a</sup>Relative to launch time; for example, 1859 EST = T+2 min.

<sup>b</sup>Charts for surface and 500 mb; also included are precipitation and maximum and minimum temperatures for the preceding 24-hr period.

<sup>c</sup>Location of the base station for upper air and surface observations is illustrated in Figure 1.

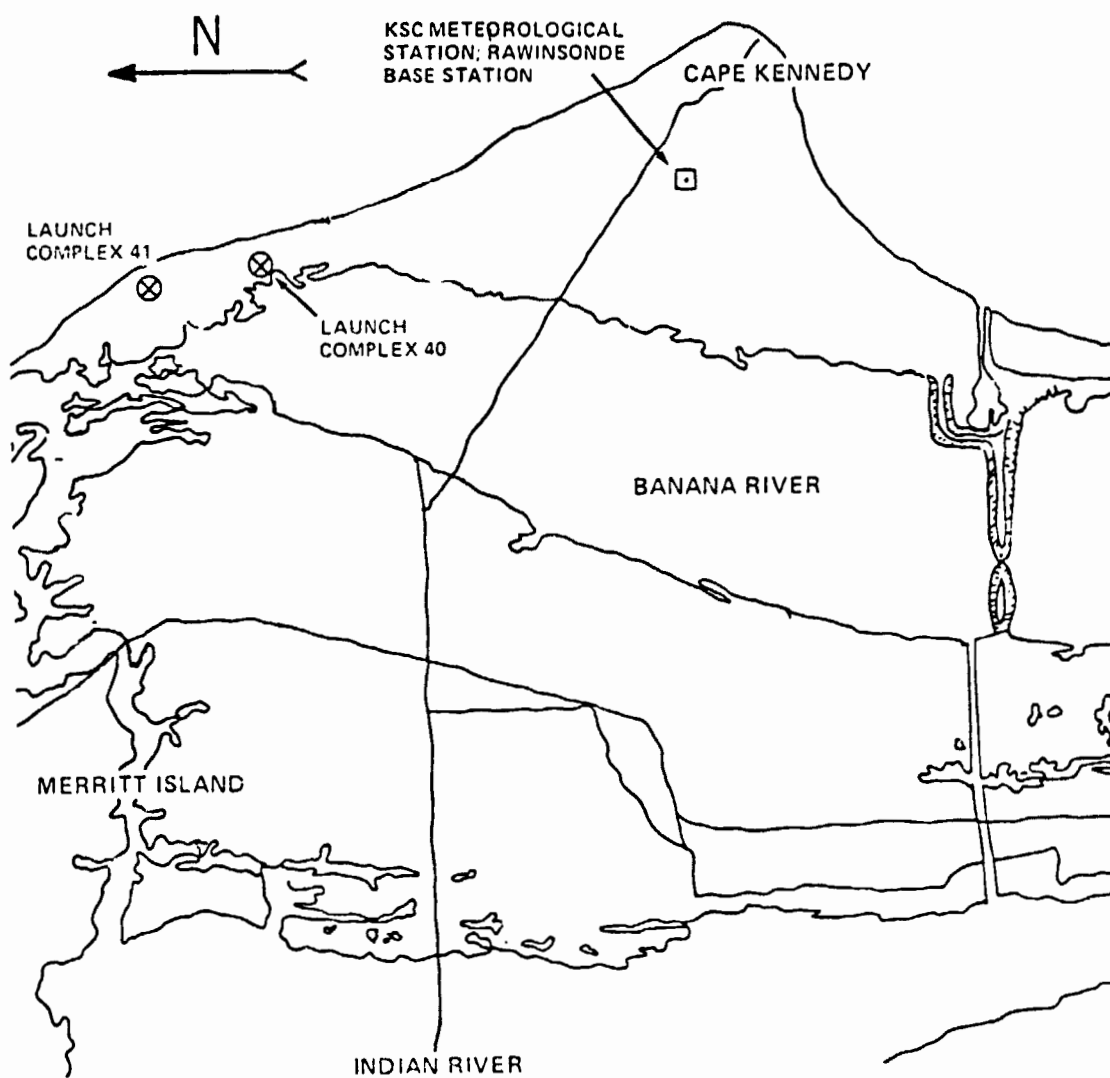


Figure 1. Location of KSC meteorological station for surface and upper air observations.



The rawinsonde runs were made with an AMQ-9 radiosonde (Fig. 2) using the GMD-4 rather than the NOAA J005B radiosonde system. The temperature and humidity sensor data are transmitted ten times per minute in the AMQ-9 by a clock-actuated switch rather than the aneroid barometer switch used in the NOAA radiosonde. Both systems measure azimuth and elevation with the directional receiver in the GMD. A transponder in the AMQ-9 is used to obtain the slant range to the radiosonde, enabling the calculation of altitude. The pressure is then calculated according to the hypsometric equation. The equations used in the computer program to calculate various thermodynamic quantities from the basic altitude, temperature, and relative humidity data are given in Appendix E.

Since it is envisioned that use of the rawinsonde data will be restricted to studies of the stabilized Space Shuttle rocket booster cloud, an altitude limit of 6.8 km (20 000 ft) was chosen; all data beyond that altitude are not included in this report. The excluded data are archived at MSFC and are available.

The data contained in this report cover a time period that is sufficient for most anticipated meteorological analyses. The chronology of the data relative to the time of launch is given in Figure 3. In most studies, data within 1.5 hours of launch time are sufficient. To facilitate retrieval of these data, an index is provided in Table 2 which gives the page number of data obtained within 1.5 hours of launch.

### III. LAUNCH CONDITIONS

At launch, the KSC meteorological station reported scattered clouds, a visibility of 10 miles, and a surface wind from the south-southwest at 7 knots. The winds aloft, measured with a rawinsonde released at T 4 minutes, were from the southwest at altitudes up to 1.83 km (6000 ft). The exhaust cloud, which was observed to stabilize at an altitude of 1.4 km (4600 ft), had a trajectory which paralleled the observed wind direction.

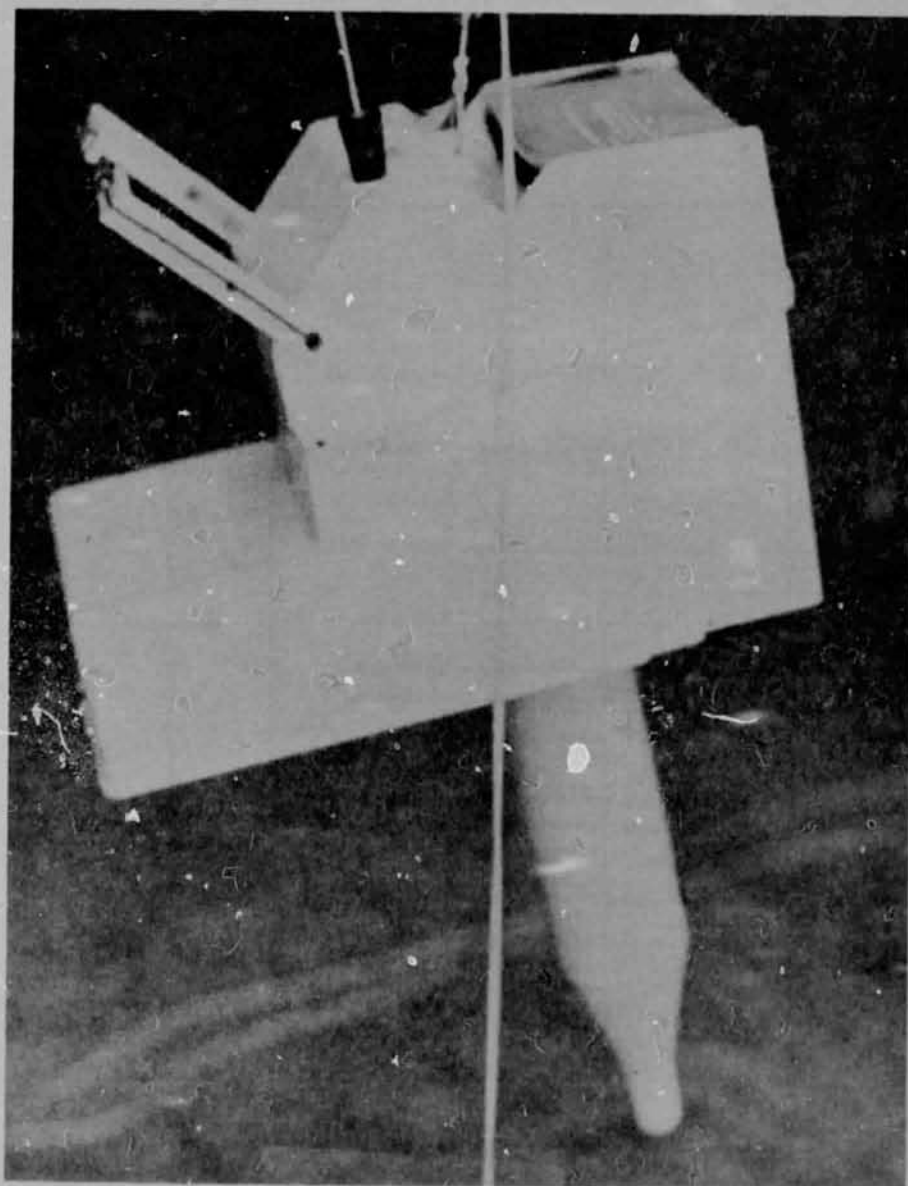


Figure 2. AMQ-9 radiosonde.

(1) EST - EASTERN STANDARD TIME  
EST - GREENWICH MEAN TIME (Z) - 5 HOURS

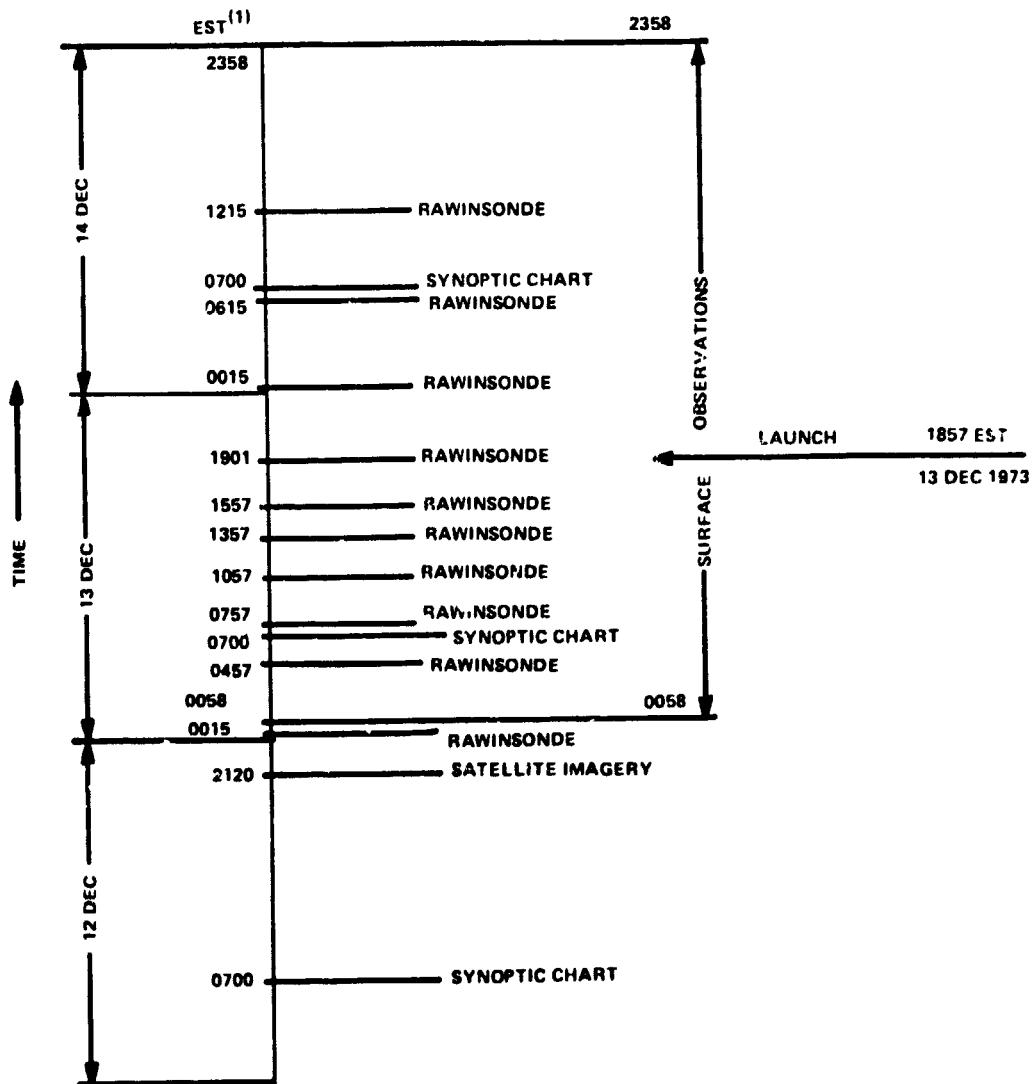


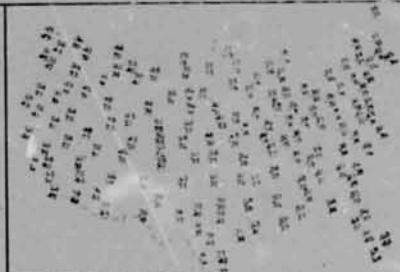
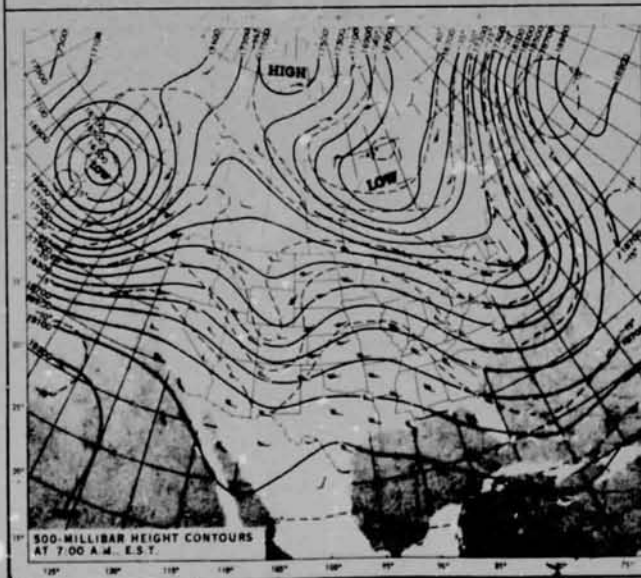
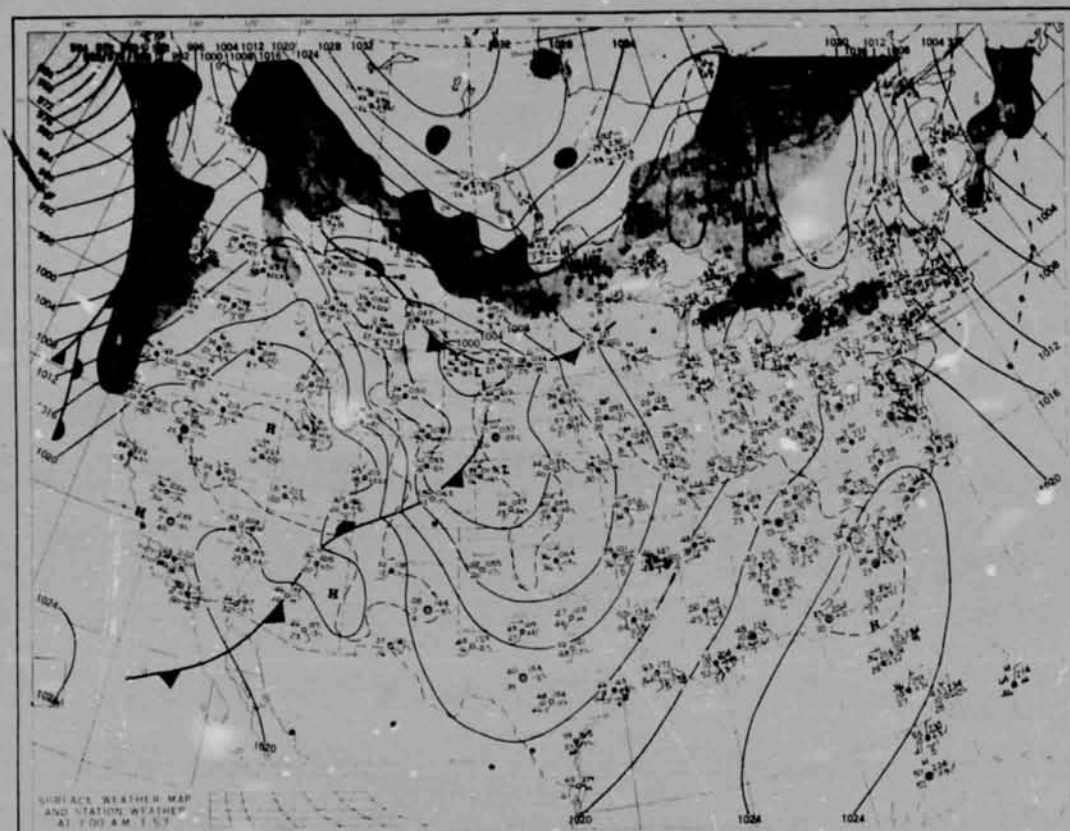
Figure 3. Data chronology.

TABLE 2. METEOROLOGICAL DATA OBTAINED WITHIN 1.5 HOURS  
OF T-0 (1857 EST, 13 DEC 1973)

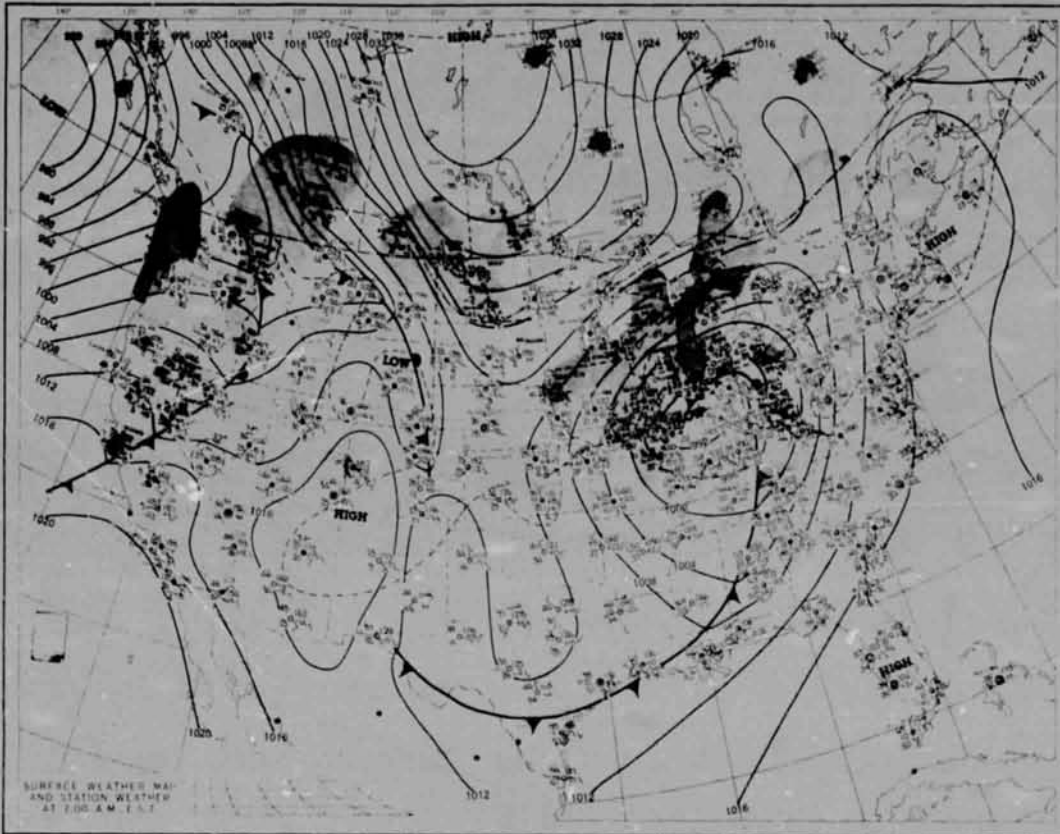
<u>Time</u>	<u>Data Type</u>	<u>Page</u>
T- 59 min	Surface Observation	13
T-0	Surface Observation	13
T+ 4 min	Rawinsonde	24
T+1 hr	Surface Observation	13

**APPENDIX A**  
**SYNOPTIC CHARTS**  
**(1973)**

WEDNESDAY, DECEMBER 12, 1973

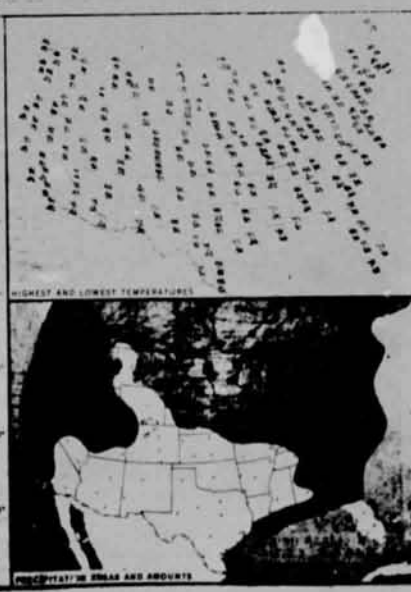
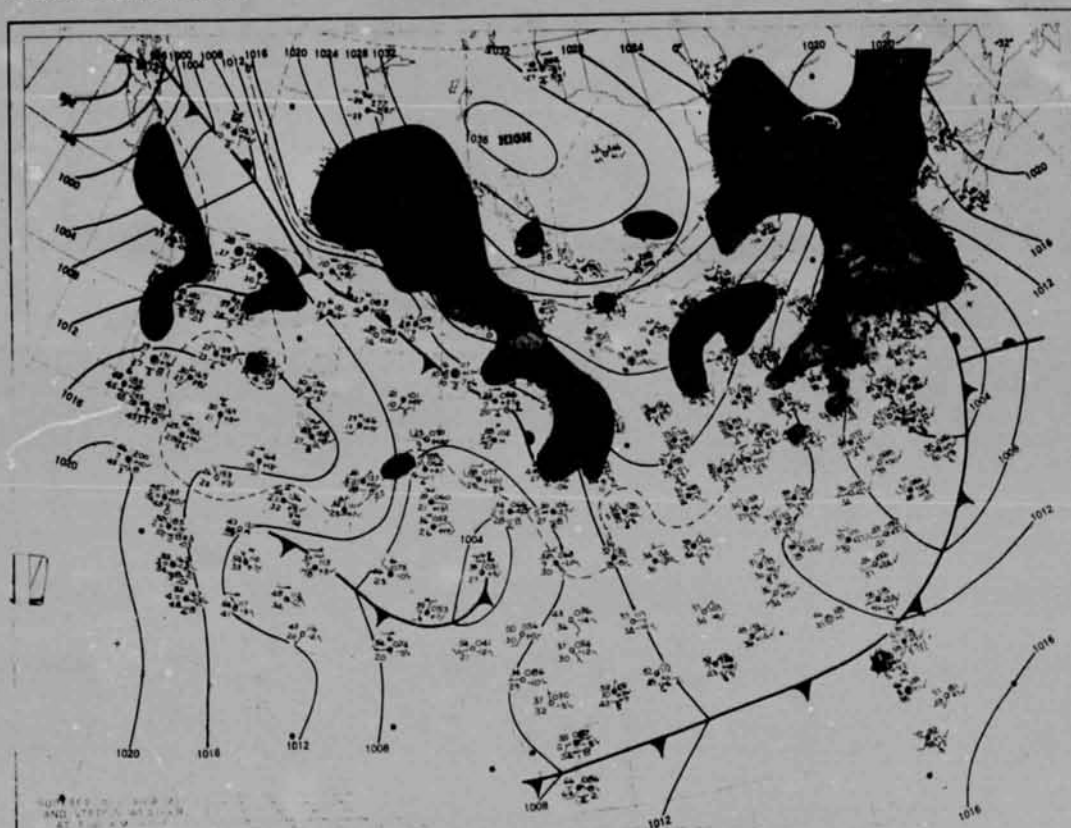


THURSDAY, DECEMBER 13, 1973





FRIDAY, DECEMBER 14, 1973





**APPENDIX B**  
**SURFACE OBSERVATIONS**  
**(KSC, 1973)**



[illegible]

APPENDIX C  
RAWINSONDE DATA  
(1973)

RAWLINS DE RH AN/UMU-4  
CAMP KENNEDY AFS, FLORIDA  
0515Z 13 DEC 1973  
ASGT IT HBR 0705

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	REL PT DEG C	PRESS HGS	MM PCT	AR HUM G/M3	DENSITY G/M3	I/R M	VS KTS	SHEAR /SEC	DEG
10	285	4	1.0	-0.1	1047.00	94	4.74	1290.00	318	645	0	0
1000	168	4	12.6	4.2	941.98	57	6.27	1193.54	304	654	.012	138
2000	175	9	12.7	-3.5	947.01	33	3.62	1152.00	279	659	.008	183
3000	189	12	11.5	.2	913.42	46	4.74	1114.97	278	657	.007	222
4000	214	12	6.4	-7.7	880.42	29	2.63	1043.99	256	655	.011	204
5000	235	11	7.9	-8.4	848.59	31	2.92	1050.28	250	653	.006	334
6000	255	11	7.2	-11.3	817.01	25	2.00	1059.05	230	652	.007	342
7000	265	11	5.9	-13.7	788.04	23	1.65	992.69	229	651	.003	347
8000	271	12	5.2	-15.7	759.45	20	1.44	949.40	220	650	.002	322
9000	275	12	4.7	-18.1	721.45	20	1.35	916.19	213	649	.002	333
10000	281	14	3.1	-20.1	704.57	16	.97	848.04	204	647	.003	319
11000	280	17	1.2	-21.1	678.90	17	.90	840.94	198	645	.006	277
12000	278	21	-0.3	-21.9	653.49	18	.84	833.98	191	644	.007	269
13000	277	25	-2.1	-23.0	628.00	18	.76	807.87	185	641	.007	271
14000	277	27	-2.5	-24.1	605.13	18	.75	791.42	179	640	.004	282
15000	279	28	-5.2	-24.7	582.23	20	.67	756.62	173	638	.002	320
16000	283	29	-6.4	-25.3	568.08	21	.61	731.17	167	636	.004	1
17000	286	28	-8.1	-26.4	538.06	21	.58	707.78	161	634	.002	37
18000	285	29	-9.3	-28.5	517.94	19	.48	683.70	155	633	.002	238
19000	285	32	-11.1	-29.6	497.91	26	.43	661.72	150	631	.005	283
20000	287	34	-13.5	-28.7	478.58	27	.44	641.77	146	629	.004	317

#### MANDATORY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	REL PT DEG C	PRESS HGS	MM PCT
1000	40	2	12.7	5.3	1000	01
2000	175	9	12.7	-2.8	950	35
3000	208	14	10.5	-0.9	900	47
4000	234	11	7.9	-8.2	850	31
5000	262	11	6.5	-12.6	800	24
6000	274	12	5.1	-18.1	750	20
7000	281	14	2.7	-20.3	700	16
8000	278	22	-0.6	-22.1	650	18
9000	278	28	-4.0	-24.6	600	16
10000	285	29	-7.7	-26.0	550	20
11000	284	31	-10.0	-28.8	500	19

#### SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	REL PT DEG C	PRESS HGS	I/R M
10	285	4	1.0	-0.1	1047.00	318
2000	175	9	12.7	-3.5	947.01	279
3000	189	12	11.5	.2	913.42	278
4000	214	12	6.4	-7.7	880.42	256
5000	235	11	7.9	-8.4	848.59	250
6000	255	11	7.2	-11.3	817.01	230
7000	265	11	5.9	-13.7	788.04	229
8000	271	12	5.2	-15.7	759.45	220
9000	275	12	4.7	-18.1	721.45	213
10000	281	14	3.1	-20.1	704.57	204
11000	280	17	1.2	-21.1	678.90	198
12000	278	21	-0.3	-21.9	653.49	191
13000	277	25	-2.1	-23.0	628.00	185
14000	277	27	-2.5	-24.1	605.13	179
15000	279	28	-5.2	-24.7	582.23	173
16000	283	29	-6.4	-25.3	568.08	167
17000	286	28	-8.1	-26.4	538.06	161
18000	285	29	-9.3	-28.5	517.94	155
19000	285	32	-11.1	-29.6	497.91	150
20000	287	34	-13.5	-28.7	478.58	146

W-1 SURVEY RPT A1/GMD-4  
 CAPE KENNEDY AFS, FLORIDA  
 0657Z 13 DEC 1973  
 1500.7 SUR 0796

ALTITUDE FEET	DIM FEET	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	WIND KTS	AB HUM G/M3	DENSITY G/M3	1/H N	VS KTS	SWEAR /SEC	DEG
10	270	4	1.4	1.1	1010.50	97	5.23	1205.65	320	646	0	0
1100	241	12	12.7	-5.2	980.55	28	3.17	1193.26	295	659	.015	226
2000	228	19	12.4	-6.7	945.00	22	2.41	1192.26	271	658	.012	207
3000	222	21	6.4	5.7	911.72	77	7.01	1119.77	293	655	.006	183
4000	224	20	7.3	4.9	878.02	85	8.72	1097.48	284	652	.002	4
5000	230	16	5.4	99.9	846.83	999	99.99	1097.32	245	650	.010	7
6000	247	13	4.7	-13.7	815.85	25	1.65	1021.92	238	640	.006	16
7000	246	16	6.7	-16.8	756.03	17	1.27	990.06	226	651	.005	245
8000	248	20	3.9	-14.3	757.24	25	1.60	991.25	222	648	.006	253
9000	247	20	2.9	-20.2	729.35	18	1.06	919.76	212	647	0	109
10000	252	21	2.1	-20.9	729.31	16	.90	898.60	204	646	.003	309
11000	258	22	-1.5	-21.9	676.29	16	.84	863.65	198	643	.004	316
12000	261	24	-2.3	-23.4	650.96	16	.74	836.83	191	641	.003	293
13000	262	26	-3.7	-25.4	626.45	17	.62	809.69	184	639	.004	281
14000	263	26	-5.3	-26.7	602.73	17	.55	783.47	178	638	.001	10
15000	266	28	-6.2	-27.6	579.01	16	.51	756.49	172	636	.004	293
16000	271	30	-7.1	-29.0	557.07	15	.45	730.04	166	635	.005	323
17000	276	31	-9.5	-29.0	536.27	19	.45	708.37	161	633	.005	341
18000	271	32	-11.7	-30.3	515.46	26	.41	686.55	156	630	.005	295
19000	280	32	-13.6	-32.6	495.37	16	.34	663.05	150	628	.010	173
20000	257	32	-15.5	-34.1	475.92	18	.29	643.24	145	625	.003	173

#### ADDITIONAL LEVELS

ALTITUDE FEET	DIM FEET	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	WIND KTS
556	253	8	12.1	1.9	1000	50
1069	224	18	12.5	-8.0	950	23
1346	221	21	8.7	5.5	900	80
4092	235	16	5.4	99.9	850	999
5515	247	14	5.6	-17.1	800	17
7242	246	26	3.4	-12.1	750	31
10072	253	21	1.0	-21.0	700	16
12015	261	24	-2.4	-23.4	650	16
14086	264	26	-5.3	-27.0	600	16
16019	274	30	-7.4	-28.9	550	16
18723	262	32	-13.1	-32.3	500	18

#### SIGNIFICANT LEVELS

ALTITUDE FEET	DIM FEET	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	1/H N
10	270	4	1.4	1.1	1010.50	340
605	255	8	12.1	2.9	1001.90	307
776	245	11	12.5	-4.1	980.46	286
1198	238	14	12.8	-6.1	973.54	262
1587	232	16	12.4	-6.5	959.89	277
2026	228	19	12.4	-6.8	944.09	271
2443	222	21	6.4	5.7	913.55	292
4313	220	19	7.0	4.4	860.72	280
4658	232	18	6.1	99.9	857.69	232
5146	238	15	5.4	-10.0	842.25	246
6084	247	13	4.4	-13.6	813.30	236
7556	246	16	6.1	-16.8	787.30	227
7720	247	20	2.8	-12.2	737.66	216
9117	247	20	3.0	-23.6	720.15	206
10050	252	21	2.1	-20.9	701.10	202
10559	250	22	.3	-22.3	697.72	201
13094	263	28	-5.9	-26.5	607.21	176
14291	273	30	-7.2	-29.0	551.37	164
16721	276	31	-8.7	-28.4	542.16	162
18487	268	32	-12.6	-31.0	509.65	154
18994	260	32	-12.9	-32.9	499.47	156
19389	258	32	-14.0	-14.6	487.73	157
19930	257	32	-15.1	-33.6	479.18	146

RAM:SONUE HUN 4470MD-4  
CAPT KENNEDY AFS, FLORIDA  
12374 13 DEC 1973  
ASLENT NOR 4797

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	MM PCT	AD HUM G/M3	DENSITY G/M3	I/M N	VS KTS	SHEAR /SEC DEG
10	280	4	2.0	0	1026.90	87	4.62	1224.55	317	646	0 0
1000	280	17	12.4	-10.2	980.77	26	2.14	1199.40	279	698	.013 266
2000	240	11	12.4	-10.0	945.01	20	2.17	1191.92	279	690	.007 168
3000	220	13	10.3	-9.7	911.95	23	2.24	1181.50	263	696	.006 187
4000	210	19	8.6	-12.8	879.08	26	1.75	1165.21	253	654	.008 180
5000	210	19	6.3	-12.0	847.10	20	1.91	1154.09	247	651	.004 170
6000	209	17	4.2	-14.9	816.40	24	1.97	1124.22	230	649	.003 12
7000	219	18	6.2	-20.4	786.48	12	1.97	1079.96	224	651	.005 286
8000	234	22	4.5	-19.3	757.33	10	1.83	1049.91	210	649	.010 291
9000	243	24	2.9	-9.9	729.67	999	99.99	970.10	211	647	.000 204
10000	249	27	1.4	-24.9	702.09	12	.64	890.64	202	644	.006 204
11000	254	28	.	-27.0	676.58	11	.53	842.59	196	644	.003 312
12000	253	28	-1.0	-28.4	651.47	11	.47	816.14	189	642	.0 283
13000	250	28	-3.5	-31.0	626.74	10	.37	779.42	183	640	.003 199
14000	251	29	-4.9	-32.1	603.04	10	.33	742.64	177	638	.002 298
15000	250	30	-5.5	-33.7	580.13	9	.28	705.02	170	637	.005 313
16000	262	32	-7.2	-33.9	558.42	10	.28	700.88	165	635	.006 317
17000	268	32	-9.3	-33.7	536.90	12	.29	718.32	160	633	.006 5
18000	271	32	-11.5	-35.7	515.43	11	.24	696.76	155	631	.003 344
19000	271	36	-13.9	-37.0	495.08	12	.21	656.06	150	627	.006 270
20000	260	38	-16.4	-38.8	476.16	12	.18	645.90	145	624	.006 211

LABORATORY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	MM PCT
1800	270	11	12.2	-6.4	1000	26
1870	249	11	12.9	-10.9	950	16
3355	224	17	9.8	-9.8	900	24
4962	211	19	6.5	-12.9	850	24
6525	210	17	4.2	-16.8	800	20
8654	237	23	4.	-20.2	750	15
10662	250	27	1.5	-23.2	700	14
12427	253	28	-2.1	-28.5	650	11
14441	254	29	-5.9	-32.2	600	10
16335	264	32	-7.9	-33.5	550	11
18740	271	35	-13.9	-36.6	500	12

SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	I/M N
10	280	4	2.0	0	1026.90	317
497	282	9	4.4	-13.2	1000.21	294
977	273	11	12.8	-6.0	999.57	206
1743	253	11	13.2	-11.9	954.66	270
6022	209	17	4.2	-15.0	819.54	237
9702	213	17	4.0	-16.5	801.01	232
9773	219	18	6.2	-20.8	787.08	244
1442	230	23	4.1	-27.0	750.69	216
1720	241	24	3.6	-11.3	737.17	216
1410	243	25	2.4	-9.9	723.93	204
1950	240	26	2.0	-24.2	712.02	205
13236	249	28	-3.9	-32.4	621.10	181
13235	257	31	-5.5	-33.7	574.67	180
13793	260	32	-6.2	-35.5	560.94	180
14775	260	38	-15.7	-38.3	480.49	140

NAME: SOURCE RUN AM/GMC-4  
 CAPT KENNEDY AFR, FLORIDA  
 1997, 18 DEC 1973  
 ASSENT 400 0700

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	RH PCT	AB HUM G/M3	DENSITY G/M3	WIND N	VS KTS	SHEAR /SEC	DEG
10	230	7	16.2	-3.6	1010.00	29	3.47	1.221,82	293	603	0	0
1000	244	10	13.6	-7.2	981.17	23	2.71	1.190,49	282	601	.007	270
2000	231	15	17.5	-8.1	946.83	21	2.59	1.148,80	271	600	.010	269
3000	210	20	11.4	-9.5	912.35	22	2.27	1.115,02	263	657	.010	167
4000	210	25	6.2	-14.1	879.74	16	1.59	1.094,38	251	659	.008	252
5000	210	27	7.4	-12.4	847.89	23	1.84	1.091,83	246	652	.009	221
6000	204	26	5.3	-13.7	817.00	24	1.66	1.071,19	238	657	.006	98
7000	219	25	5.6	-16.0	787.09	16	1.19	1.063,08	226	650	.007	313
8000	237	25	5.2	-18.7	758.35	16	1.09	1.049,63	218	650	.013	173
9000	249	24	2.7	-21.4	730.57	15	.87	1.022,01	211	647	.008	340
10000	250	25	.9	-21.4	703.44	17	.80	1.003,59	205	645	.004	306
11000	255	26	.1	-23.7	677.47	15	.71	1.003,14	197	644	.004	317
12000	258	27	-1.6	-25.2	651.98	14	.63	1.005,99	190	642	.003	305
13000	263	30	-3.6	-27.4	627.42	14	.52	1.010,73	184	640	.006	303
14000	269	34	-5.0	-28.4	603.86	14	.47	1.013,84	178	638	.008	311
15000	274	34	-5.9	-29.1	580.74	14	.44	1.016,63	171	637	.005	347
16000	278	32	-7.9	-30.5	558.34	14	.39	1.033,31	164	636	.003	78
17000	277	32	-6.7	-31.7	537.06	15	.39	1.010,02	160	632	.002	13
18000	270	31	-12.4	-33.2	516.44	15	.31	1.008,99	159	630	.003	112
19000	260	31	-14.4	-33.2	496.05	15	.25	1.017,63	150	627	.007	103
20000	262	32	-16.4	-36.8	476.47	15	.22	1.046,99	146	624	.006	193

MANDATORY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	RH PCT
573	240	8	14.7	-4.6	1000	26
1000	234	15	13.7	-6.0	950	21
3574	210	22	10.6	-12.6	900	16
4924	210	27	7.5	-12.9	850	22
6552	213	25	4.8	-15.7	800	21
7482	241	24	4.3	-19.2	750	16
10410	251	25	.4	-21.7	700	17
12055	258	28	-1.7	-25.4	650	14
14128	270	34	-5.0	-28.6	600	14
16358	275	32	-8.4	-31.0	550	14
18750	264	30	-13.0	-34.8	500	15

SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	WIND N
10	230	7	16.2	-3.6	1010.00	293
1136	243	11	17.3	-7.6	970.34	260
1513	237	13	14.7	-7.1	903.14	276
3909	204	20	5.3	-13.6	817.15	238
6577	213	25	4.6	-14.2	800.59	235
7484	225	25	4.4	-18.1	770.01	241
10130	251	25	.4	-21.5	700.76	244
14480	258	28	-2.1	-25.6	640.00	184
16605	260	29	-3.7	-28.4	630.98	208
18741	278	35	-9.6	-28.9	591.10	174
18955	275	33	-8.7	-31.2	544.34	162



RAMINSUNUE RUN 44/000-4  
CAPE KENNEDY AFB, FL0410P  
18574 13 DEC 1973  
ASCENT RUN 0700

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS PSS	RM PCT	APMUM G/H3	DENSITY G/M3	I/R N	VS FTS	SHEAR /SEC	DEG
10	200	11	21.0	.5	1012.90	26	4.67	1196.90	294	600	0	0
1000	217	16	19.0	-4.0	977.90	24	3.25	1176.72	282	602	.011	240
2000	222	20	14.0	-8.4	943.44	20	2.91	1170.72	260	601	.016	230
3000	223	31	13.4	-10.0	909.97	18	2.14	1175.16	250	659	.009	270
4000	222	32	10.0	-16.7	877.90	16	1.20	1076.90	240	650	.004	300
5000	239	30	6.0	-17.7	849.06	12	1.16	1040.27	230	659	.000	342
6000	249	20	7.4	-21.0	815.40	11	.04	1011.74	231	653	.012	390
7000	250	25	9.4	-24.3	785.59	9	.06	981.37	223	650	.000	10
8000	253	23	8.0	-26.5	766.74	9	.04	952.08	210	640	.004	109
9000	251	20	3.0	-28.4	720.82	7	.46	917.06	207	640	.005	234
10000	251	30	1.0	-29.0	701.90	6	.44	899.00	201	646	.007	240
11000	252	30	-0.7	-30.2	675.77	6	.39	864.00	195	643	.001	270
12000	253	32	-2.0	-31.0	650.41	9	.34	830.24	180	640	.004	272
13000	260	35	-3.7	-32.6	625.05	8	.31	809.00	182	639	.008	320
14000	274	37	-3.0	-33.0	602.10	6	.20	770.12	175	640	.011	300
15000	274	38	-5.5	-34.1	579.37	8	.27	754.10	170	637	.005	347
16000	278	38	-7.3	-35.1	557.27	8	.23	730.20	164	635	.006	14
17000	282	39	-6.4	-37.3	535.05	8	.20	700.19	159	632	.004	337
18000	283	39	-8.7	-38.4	515.06	0	.10	680.10	154	629	.002	47
19000	274	34	-15.2	-40.0	464.07	0	.19	640.38	150	626	.012	150
20000	260	36	-12.1	-42.4	479.20	10	.12	640.07	145	622	.007	190

#### SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS PSS	I/R N
10	200	11	21.0	.5	1012.90	294
411	211	10	18.0	-1.5	1005.95	294
800	214	13	16.0	-3.1	989.03	290
2427	223	20	14.4	-17.6	929.03	250
4930	223	31	13.7	-8.7	914.27	261
3494	224	32	12.1	-18.5	900.33	251
5519	241	20	7.0	-20.0	829.00	244
5995	247	20	7.5	-21.5	815.45	231
6077	250	20	6.0	-24.2	780.19	223
7312	250	24	4.9	-24.0	770.51	221
8507	254	24	2.4	-27.0	739.05	211
9060	252	20	3.0	-28.5	720.97	207
12450	250	34	-2.9	-32.4	639.05	180
14040	270	37	-3.5	-33.5	601.13	175
17100	282	39	-10.0	-37.5	531.04	150
17563	283	39	-11.3	-38.4	524.07	150
18303	281	37	-12.4	-39.7	507.00	154
18954	278	35	-14.4	-40.4	501.70	151
19402	270	34	-16.4	-41.7	489.05	140
19900	260	35	-18.0	-42.3	477.03	140

#### WINDY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS PSS	RM PCT
970	214	11	18.1	-2.4	1000	25
1035	222	24	15.0	-6.5	950	27
3200	220	32	12.1	-10.4	900	10
4850	234	31	11.7	-17.3	850	13
6500	250	27	6.9	-22.0	800	10
8424	252	23	3.1	-26.0	750	9
10453	251	30	1.4	-29.1	700	0
11793	253	32	-2.9	-31.0	650	9
14065	270	30	-2.6	-33.0	600	0
16400	280	30	-6.2	-36.4	550	0
18700	277	35	-14.0	-40.0	500	0

RAH1 (SONUE RUN AH/QMD-4  
CAPE KENNEDY AFS, FLORIDA  
20374 13 DEC 1973  
ASCENT NUM 0000

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	AM PCT	AM Q/M3	DENSITY G/M3	W/H N	VS KTS	SHEAR /SEC DEG
10	190	12	20.0	0.0	1020.00	40	0.90	1196.00	300	667	0
1000	202	21	17.7	-1.1	976.10	29	4.20	1168.03	286	664	.010 217
2000	208	24	14.6	-3.1	941.78	20	3.66	1130.07	276	661	.007 242
3000	220	29	12.3	-5.9	908.23	26	3.07	1106.90	269	658	.009 290
4000	232	22	10.0	-15.7	875.28	14	1.37	1073.20	240	656	.010 349
5000	242	16	8.4	-18.7	844.27	11	1.08	1036.73	230	656	.012 29
6000	250	14	6.0	-20.0	813.06	23	2.30	1009.08	210	654	.007 10
7000	261	17	6.4	-11.3	782.33	27	1.99	976.22	230	651	.006 209
8000	260	23	4.0	-19.8	755.01	19	1.29	949.99	219	650	.009 270
9000	267	28	4.8	-20.4	728.01	7	.45	912.36	206	640	.010 279
10000	260	42	2.9	-31.5	701.42	6	.34	886.04	200	647	.000 260
11000	260	33	2.2	-33.5	675.41	6	.29	860.24	193	644	.002 276
12000	271	34	-1.4	-32.3	649.96	6	.32	834.47	186	642	.009 342
13000	277	36	-3.2	-30.1	625.90	6	.22	807.17	181	640	.007 330
14000	280	38	-4.1	-37.0	601.87	6	.20	779.36	179	639	.009 310
15000	277	39	-6.9	-30.2	579.08	4	.18	756.43	170	636	.004 226
16000	276	41	-4.4	-39.9	556.88	6	.16	732.08	164	634	.004 230
17000	273	43	-10.5	-39.9	535.43	7	.16	709.09	159	631	.004 226
18000	268	42	-19.1	-48.1	514.30	7	.14	689.00	154	629	.009 179
19000	267	43	-16.0	-43.0	494.27	8	.11	669.06	150	629	.004 186
20000	260	43	-10.5	-44.5	474.04	0	.10	649.20	149	622	.003 0

#### MANDATORY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	AM PCT
117	197	13	16.4	4.0	1000	30
1754	206	24	15.0	-2.7	750	29
3449	224	29	11.8	-6.2	900	20
4007	240	17	10.5	-19.7	850	10
6455	250	19	7.4	-12.6	800	22
8180	265	24	5.0	-17.1	750	10
10027	264	32	2.4	-31.6	700	6
11075	271	34	-1.9	-32.3	650	8
14051	280	38	-4.3	-37.2	600	6
16470	274	42	-5.2	-39.8	550	6
18071	267	43	-15.4	-42.6	500	0

#### REMARKS LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	W/H N
10	190	12	20.0	0.0	1020.00	300
403	194	17	15.0	4.1	770.03	300
882	201	20	17.6	-1.1	900.41	207
1329	203	23	16.6	-1.3	964.83	203
1731	206	24	15.0	-2.7	950.00	270
3554	227	24	11.0	-7.0	890.00	200
3702	232	22	10.4	-15.6	876.28	240
5458	240	14	1.4	-15.4	830.42	247
5713	251	14	5.2	-5.0	824.51	244
7504	263	20	5.4	-12.6	764.79	246
8930	267	20	4.9	-20.4	724.76	207
12708	275	35	-3.2	-15.3	631.09	183
13102	270	36	-3.3	-16.7	620.12	180
14041	280	38	-4.2	-37.2	600.91	179
16422	268	43	-13.4	-41.8	584.97	153
18504	267	43	-15.3	-42.4	504.01	152

KAWI-SUNDBE RUN 44/800-4  
 CAPE KENNEDY AFB, FLORIDA  
 30012 14 DEC 1973  
 ASSENT RUN 6801

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	MM PCT	AM HUM G/M3	WIND G/M3	1/R 4	VS KTS	SHEAR /SEC DEG
10	210	7	15.3	6.0	1011.50	97	7.41	1217.12	316	662	0 0
1000	221	25	12.7	4.3	976.72	38	6.14	1141.98	296	666	.031 229
2000	231	28	12.6	4.3	942.50	46	6.21	1171.01	290	662	.009 208
3000	241	28	13.1	5.0	909.40	50	6.50	1142.97	286	659	.008 199
4000	244	27	12.9	5.1	876.70	60	6.60	1072.00	280	656	.003 190
5000	243	18	8.3	-4.7	845.41	38	3.39	1048.87	253	455	.015 71
6000	252	14	8.0	-6.3	814.75	39	3.42	1044.38	245	454	.009 58
7000	276	11	7.8	-3.7	789.40	46	4.59	973.54	230	659	.000 17
8000	291	15	5.2	-3.7	756.72	53	3.61	944.74	233	652	.000 333
9000	291	19	2.7	-0.7	728.90	70	4.55	917.73	233	647	.007 349
10000	290	10	.4	-1.6	702.02	66	4.31	891.30	226	644	.003 191
11000	289	19	-0.1	-11.0	675.42	41	2.09	840.90	205	644	.003 214
12000	279	22	-1.4	-24.2	650.70	15	.60	831.90	190	643	.007 250
13000	276	28	-3.0	-11.1	626.49	54	2.11	846.27	193	642	.010 263
14000	276	33	-4.2	-24.8	602.06	19	.79	798.17	178	639	.009 296
15000	280	34	-5.0	-33.0	578.06	0	.80	794.00	170	637	.009 300
16000	280	34	-7.4	-32.3	557.07	12	.34	776.77	165	639	0 199
17000	277	36	-8.7	-27.1	536.23	23	.54	770.00	162	632	.003 197
18000	275	37	-12.3	-26.9	513.44	29	.58	698.85	157	629	.003 250
19000	277	41	-15.7	-23.4	489.23	31	.74	640.54	154	625	.007 299
20000	276	47	-18.2	-25.9	475.50	52	.69	640.41	146	624	.007 278

MANDATORY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	MM PCT
330	210	17	10.0	-0.4	1000	33
1726	224	20	10.6	4.5	950	45
1676	242	20	12.6	5.1	900	60
1636	243	21	8.2	1.3	850	60
158	243	12	8.2	-4.4	800	41
1225	204	14	4.8	-2.1	750	61
11057	290	10	.4	-1.8	700	65
12404	279	22	-4.0	-24.2	650	16
14089	276	34	-4.4	-25.2	600	16
15318	279	36	-8.1	-20.3	550	16
16718	276	40	-12.6	-23.6	500	47

SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	1/R 4
10	210	7	15.3	6.0	1011.50	316
344	217	24	17.7	-5.0	994.62	281
559	220	25	18.9	4.4	970.15	290
1080	237	28	14.4	5.0	922.41	280
1472	240	28	12.1	5.0	910.11	286
1410	243	28	12.4	5.2	895.81	284
1661	244	27	17.9	5.3	881.29	282
1412	244	27	9.0	4.6	870.83	278
1640	244	25	8.3	4.5	856.40	276
1476	243	22	7.7	4.1	852.88	274
1013	243	18	7.3	-5.2	844.80	291
1434	244	16	6.0	-7.7	831.85	244
1090	290	10	2.0	-1.5	737.51	243
1684	205	19	2.5	-0.5	720.60	243
1419	291	18	.4	-1.3	704.17	227
14091	280	18	.2	-2.8	691.71	221
12090	289	19	-1	-11.4	670.99	208
11402	282	20	-0.6	-8.9	665.87	208
11011	279	22	-0.3	-24.3	655.48	191
12593	270	21	-6.7	-24.8	641.00	180
14538	276	26	-2.8	-14.7	627.79	198
13018	276	28	-3.9	-10.1	629.84	194
13337	277	32	-8.3	-27.1	618.23	188
14081	286	35	-9.0	-34.3	604.73	171
14222	279	36	-7.7	-38.3	592.89	164
1740	278	36	-11.6	-29.8	589.06	180
16416	279	38	-13.0	-27.2	581.84	180
24 10078	276	39	-14.9	-23.7	581.78	180

LAKE-SOUND RUM AN/GMU-4  
 LAKE KENNEDY AFS, FLORIDA  
 0515Z 19 DEC 1973  
 ASCELT BR 0802

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEPT DEG C	PRESS HRS	RM PCT	AM HUM G/M3	DENSITY G/M3	W/R N	VS KTS	SWEAT /SEC DEG
10	220	13	15.5	10.7	1011.90	73	9.69	1215.37	329	662	0 0
2000	239	32	15.0	10.9	976.08	73	9.70	1171.63	320	662	.034 251
2000	247	31	15.4	9.6	942.32	70	9.24	1132.31	308	662	.008 347
3000	259	29	15.1	3.4	919.31	46	5.91	1095.48	280	661	.007 7
4000	260	27	13.6	4.1	877.15	53	6.19	1052.09	274	660	.006 25
5000	269	26	11.8	4.3	845.91	64	6.35	1033.86	260	659	.004 24
6000	268	25	9.1	3.7	815.58	70	6.15	1013.43	262	654	.003 31
7000	268	24	6.1	1.4	786.00	72	5.25	977.67	251	651	.002 39
8000	266	23	3.6	1.1	757.27	63	5.19	949.98	244	649	.001 164
9000	264	4	1.6	-1.7	729.37	79	4.20	922.24	233	646	.002 215
10000	263	26	-1.7	-2.7	702.32	62	3.99	893.31	225	644	.003 256
11000	269	28	-4.4	-18.9	676.15	56	2.51	862.18	208	643	.004 275
12000	269	29	-18.4	-18.4	650.96	24	1.14	829.63	192	644	.001 3nd
13000	267	30	-2.3	-17.4	626.61	36	1.24	805.13	187	641	.002 365
14000	270	32	-5.1	-13.1	602.97	55	1.63	782.41	186	638	.004 302
15000	272	45	-7.2	-14.9	580.01	54	1.50	758.86	179	635	.005 303
16000	275	37	-8.7	-15.9	557.78	56	1.45	734.00	173	633	.005 311
17000	277	38	-11.6	-17.0	536.27	56	1.27	710.72	167	631	.003 325
18000	280	40	-12.4	-21.2	515.44	46	.95	688.20	160	629	.003 328
19000	282	42	-14.0	-23.5	495.26	46	.77	667.73	154	626	.005 325
20000	284	45	-16.4	-36.2	475.76	36	.45	646.21	146	624	.007 325

#### MANDATORY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEPT DEG C	PRESS HRS	RM PCT
346	231	20	15.7	10.6	1000	72
1777	246	31	15.3	11.6	950	80
3461	256	29	14.2	2.3	900	43
4059	264	26	11.1	4.3	850	63
7212	266	24	7.3	2.1	800	69
8111	265	23	3.1	.8	750	66
10000	263	26	-0.1	-2.6	700	64
14015	265	29	-6.1	-18.3	650	24
14099	270	32	-5.4	-12.3	600	54
16022	276	38	-9.3	-16.1	550	57
17719	282	41	-14.2	-23.3	500	46

#### SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEPT DEG C	PRESS HRS	RM PCT
10	220	13	15.5	10.7	1011.90	329
876	230	32	14.1	10.5	981.22	321
1019	245	32	15.2	13.0	955.46	324
2460	251	31	15.7	5.6	927.09	290
3319	258	29	14.7	2.2	890.95	274
5593	265	24	2.4	.6	743.42	241
9327	263	25	1.1	-3.2	711.45	260
11702	264	28	-1.4	-2.5	683.84	221
11499	264	29	.6	-19.4	660.50	196
1444	266	29	-1.2	-18.0	644.74	191
1361	266	30	-3.1	-17.2	619.65	186
14193	270	33	-5.6	-11.9	595.50	186
19461	283	42	-15.7	-23.7	490.10	153

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ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	WV PCT	AR HUM G/H3	TEMPITY G/H3	I/R M	VS KTS	SMOAR /SEC	DER
10	220	12	13.9	11.3	1011.40	00	10.17	1224.00	339	659	.000	0
1000	230	33	17.2	10.4	976.20	95	13.97	1142.67	343	664	.037	245
2000	250	33	16.5	11.2	942.07	71	9.99	1127.22	312	663	.019	330
3000	260	30	14.4	11.3	900.92	02	10.20	1094.90	306	661	.010	10
4000	260	29	12.5	9.2	876.75	00	8.63	1063.92	291	658	.004	42
5000	270	27	10.2	7.3	849.46	02	7.82	1034.91	279	656	.003	50
6000	272	26	8.1	5.3	819.33	04	6.91	1005.39	267	653	.002	50
7000	274	27	6.6	1.1	789.90	00	5.13	975.71	249	651	.003	346
8000	278	30	4.8	-3.9	756.09	53	3.57	946.37	233	650	.005	290
9000	274	31	3.7	-0.9	720.16	72	4.40	914.00	232	648	.002	263
10000	281	33	1.6	-.2	702.20	91	4.90	887.57	229	646	.005	315
11000	283	35	-.2	-1.2	676.25	90	4.44	859.31	220	644	.003	305
12000	284	37	-2.6	-2.6	651.02	96	4.03	834.11	212	641	.003	302
13000	280	39	-4.6	-4.8	626.39	100	3.67	808.72	204	639	.004	302
14000	284	42	-6.1	-7.5	602.03	90	2.88	784.57	194	637	.005	309
15000	284	41	-7.8	-8.3	579.08	90	2.66	760.62	187	639	.003	180
16000	286	41	-11.0	-29.1	557.47	21	.44	740.53	168	631	.002	45
17000	289	41	-10.7	99.9	535.87	99	99.90	711.13	167	631	.004	5
18000	294	43	-12.5	99.9	515.02	99	99.90	686.66	15	629	.006	391
19000	295	46	-14.3	-36.6	494.06	13	.22	665.90	150	627	.005	328
20000	295	47	-17.1	-38.3	475.31	14	.19	646.49	145	623	.003	352

# MANDATORY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	WV PCT
320	220	19	14.9	13.1	3000	61
1762	251	34	16.6	13.2	956	01
3669	260	30	12.0	11.1	900	63
6045	270	27	11.5	7.5	850	02
8495	273	26	7.6	3.3	800	75
10430	270	30	4.7	-2.0	750	98
12067	282	34	1.5	-.4	700	92
12417	284	37	-2.1	-2.0	650	96
14092	287	42	-6.4	-9.1	600	03
16035	287	41	-10.7	-30.8	550	10
18096	294	45	-13.0	-36.3	500	13

# SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	I/R
10	220	12	13.2	11.3	1011.20	339
1434	241	34	17.4	10.3	970.80	341
2001	259	33	16.5	11.2	942.04	311
4000	270	27	11.2	7.3	840.45	276
5701	272	26	8.5	6.5	824.53	272
6920	275	26	6.9	.6	787.62	246
7309	277	27	6.0	3.1	770.57	252
7924	278	29	4.8	-4.3	759.03	263
9170	270	31	3.9	-0.4	724.34	257
9350	279	32	2.4	-3.8	719.51	248
9823	281	33	1.9	-0.9	712.31	224
12580	284	38	-2.9	-2.9	630.75	208
13057	286	41	-5.4	-5.6	600.14	197
14322	287	42	-7.4	-11.0	590.34	187
14394	280	42	-7.8	-12.5	594.60	186
14572	284	42	-7.0	-7.5	589.57	190
15456	284	41	-7.6	-8.5	578.50	186
15714	285	41	-11.1	-28.0	559.39	166
16734	288	41	-10.7	-33.1	540.46	182
17501	291	42	-11.7	99.9	520.70	156
17601	293	43	-13.1	-35.7	510.91	154

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ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	MM PCT	AP HUM G/43	DENSITY G/M3	1/K N	VS KTS	SHEAR /SEC DEG
10	250	13	2.4	17.2	1043.40	80	14.54	1192.10	352	668	0 0
1000	248	19	18.4	15.5	978.04	64	13.06	1151.36	337	665	.011 245
2000	253	21	16.2	14.9	944.49	92	12.67	1129.56	320	663	.004 302
3000	264	21	14.8	12.4	911.30	86	10.93	1095.77	111	661	.007 341
4000	270	24	13.6	7.2	879.12	65	7.76	1063.33	284	660	.010 336
5000	285	28	11.4	4.0	847.85	60	6.14	1034.22	268	657	.009 320
6000	285	32	5.4	3.5	817.48	66	6.63	1014.17	261	655	.007 289
7000	261	32	7.7	4.1	788.01	78	6.32	973.72	256	653	.004 280
8000	270	31	5.7	4.3	759.41	91	6.44	944.76	251	651	.005 175
9000	271	31	4.1	7	731.86	78	5.02	916.19	236	649	.005 160
10000	267	33	2.4	1.3	704.79	91	5.26	887.16	231	647	.005 221
11000	274	35	2.1	99.9	678.76	999	69.99	859.03	192	646	.008 342
12000	277	35	.5	-20.2	653.57	20	.97	831.53	191	644	.003 347
13000	277	36	-1.3	-20.8	629.18	21	.93	805.66	186	642	.002 296
14000	270	38	-2.5	-27.4	605.58	14	.57	779.13	177	641	.002 296
15000	270	38	-3.6	-33.1	582.75	8	.30	753.51	170	639	.001 287
16000	277	39	-5.4	-31.7	560.66	11	.35	730.33	165	637	.001 241
17000	277	40	-8.2	-30.4	539.24	15	.39	708.77	160	634	.002 261
18000	277	42	-10.6	-37.1	518.45	9	.21	687.85	155	631	.003 281
19000	270	44	-13.0	-29.5	498.28	23	.44	666.94	152	628	.004 297
20000	280	45	-15.1	-30.8	478.74	25	.39	645.96	147	626	.003 324

#### MANDATORY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	MM PCT
987	249	15	15.9	16.6	1000	81
1034	252	21	16.5	15.0	950	91
1042	265	22	14.5	11.9	900	79
4222	285	28	11.6	4.1	850	60
1078	284	34	5.7	2.9	800	67
1020	275	31	5.2	1.7	750	79
1062	267	34	2.4	1.1	700	91
1220	277	35	.2	-27.0	650	20
14212	270	38	-2.7	-32.0	600	11
16456	277	39	-7.0	-30.0	550	14
18570	278	44	-12.9	-29.3	500	24

#### SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	1/K N
10	250	13	2.4	17.2	1013.20	352
1094	252	21	16.4	15.0	948.05	330
2703	260	21	15.1	13.7	921.09	318
4257	262	25	13.1	4.9	867.80	275
1078	264	34	5.7	2.9	800.32	236
7111	280	32	7.4	5.0	784.80	258
7029	277	32	5.7	4.6	764.22	253
7784	270	31	5.7	4.5	759.85	252
5584	273	31	4.8	-0.3	743.09	236
8743	274	31	4.4	1.1	730.72	230
9525	268	32	1.1	1.3	717.46	244
10080	270	34	1.4	.2	694.84	227
10415	274	35	2.7	99.9	680.94	192
11051	277	35	1.2	-20.6	662.27	193
14233	270	38	-2.1	-33.2	593.32	172
16425	277	42	-10.6	-38.3	515.90	154
18517	278	44	-12.7	-29.1	501.92	154

APPENDIX D  
SATELLITE IMAGERY (IR)  
(1973)

SATELLITE IMAGERY (IR)



NOAA 2 ORBIT 5314, 12 DECEMBER 1973, 2120 EST



**APPENDIX E**

**CALCULATION OF THERMODYNAMIC VARIABLES  
FROM RAWINSONDE DATA**

The equations used for calculation of thermodynamic variables from measurements of altitude, temperature and relative humidity obtained from the GMD-4, AMQ-9 rawinsonde system are summarized herein; these equations, originally developed for the GMD-2 system (Ref. 1), must be used in conjunction with the list of symbols and units provided at the end of this appendix.

Atmospheric Density,  $\rho$

$$\rho = 348.38 \frac{P}{T_v}$$

Pressure,  $P$

$$P = P' 10^{-(h-h')/(221.266 T_{vm})}$$

Geopotential Height,  $h$

$$h = \frac{g_0}{9.8} \frac{r_e H}{r_e + H}$$

Virtual Temperature,  $T_v$

$$T_v = T(1 + .376932 e/P')$$

Mean Virtual Temperature,  $T_{vm}$

$$T_{vm} = \frac{T'_v + T_v}{2}$$

Vapor Pressure,  $e$

$$e = 6.11 f_D 10^{7.5t/(t+237.3)}$$

Dew Point Temperature,  $t_d$

$$t_d = \frac{237.3 \log e - 186.527}{8.236 - \log e}$$

Potential Temperature,  $\theta$

$$\theta = T \left( \frac{1000}{P} \right)^{.288}$$

Virtual Potential Temperature  $\theta_v$

$$\theta_v = T_v \left( \frac{1000}{P} \right)^{.288}$$

Absolute Humidity,  $\rho_w$

$$\rho_w = 216.7 e/p$$

Microwave Refractive Index,  $n$

$$n = 1 + \left[ \frac{1}{T} \left( 77.6P - 11e + \frac{374808e}{T} \right) \right] 10^{-6}$$

For data tabulation, use:

$$N = (n-1)10^6$$

Speed of Sound,  $V_s$

$$V_s = 643.855 \left( \frac{T}{273.16} \right)^{0.5}$$

# LIST OF SYMBOLS AND UNITS

e	vapor pressure	millibars (mb)
$f_D$	relative humidity expressed as a decimal	
$g_0$	acceleration of gravity at geographical location of the rawinsonde station	meters/seconds <sup>2</sup> (m/sec <sup>2</sup> )
h	geopotential height at the top of the layer bounded by h and h'	feet (ft)
h'	geopotential height at the bottom of the layer bounded by h and h'	(ft)
H	geometric altitude at the top of the layer bounded by H and H'	(ft)
H'	Geometric altitude at the bottom of the layer bounded by H and H'	(ft)
n	microwave refractive index	
N	unit of refractive index used for simplification of data tabulation	
P	pressure at geopotential height h	(mb)
p'	pressure at geopotential height h'	(mb)
$r_e$	radius of the earth	(ft)
t	temperature	degrees Celsius (°C)
T	temperature	degrees Kelvin (°K)
$t_d$	dew point temperature	(°C)
$T_v$	virtual temperature at geopotential height h	(°K)

$T_v'$	virtual temperature at geopotential height $h'$	(°K)
$T_{vm}$	the mean virtual temperature of layer bounded by $h$ and $h'$	(°K)
$V_s$	speed of sound	knots
$\rho$	atmospheric density	grams/meter <sup>3</sup> (gm/m <sup>3</sup> )
$\rho_w$	absolute humidity	(gm/m <sup>3</sup> )
$\theta$	potential temperature	(°K)
$\theta_v$	virtual potential temperature	(°K)

#### REFERENCE

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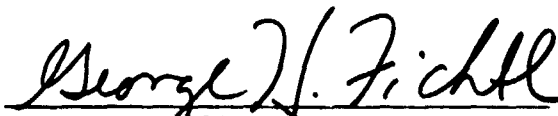
## APPROVAL

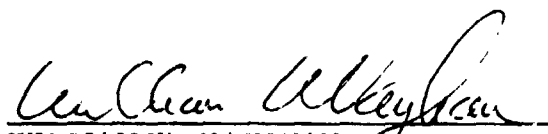
### COMPENDIUM OF METEOROLOGICAL DATA FOR THE TITAN III C LAUNCH IN DECEMBER 1973

By J. Briscoe Stephens, S. I. Adelfang, and A. I. Goldford

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

  
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